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15 December 1973

Type I Progress Report for the Period 14 August to 14 October 1973 for ERTS-1 Data User Investigation of the Use of ERTS Imagery in Reservoir Management and Operation - Proposal Number MMC 89

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The eighth 2-month period of our participation in the ERTS-1 program has been featured by:

a. Continued collection and entry of all DCS and ground truth data into our computer, and continued analysis of this data to provide up-to-date system reliability and data availability statistics.

b. Continued work in the preparation of the Proceedings of the ERTS-1 Data Collection Workshop held at Wallops Station, Virginia on 30-31 May 1973, in cooperation with personnel from NASA GSFC, Maryland and Wallops Station, Virginia.

c. Receipt of filled-in questionnaires from Corps of Engineers offices throughout the United States relating to present status of and future needs for automated data collection facilities (see July 1973, Type II Report for a copy of the questionnaire). A summary and discussion of the information obtained by the questionnaires is presently in preparation and will be included in our upcoming Type II Report.

d. Preliminary analysis of pertinent data and ERTS imagery from the late June, early July 1973 New England flood (see July 1973, Type II Report for further details) to support our study of the potential usefulness of satellite imagery and data collection for NED water related purposes both during and after a significant flood event.

e. With the snow season approaching, special emphasis, in our imagery studies, upon development of techniques for utilizing ERTS imagery for snow cover mapping.

f. Progress toward preparation of a technical report detailing all of our activities to date in the development of methods for

ERTS-1 DATA USER  
INVESTIGATION OF THE USE OF ERTS IMAGERY  
IN RESERVOIR MANAGEMENT AND OPERATION  
Progress Report, 14 (Corps of Engineers,  
Waltham, Mass.) 7 p HC \$3.00 CSCL 08H  
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analyzing ERTS imagery products to aid Corps watershed management functions. We expect to include this as part of our next Type II Report.

A listing of the locations of our operating DCP's and the remaining proposed site is inclosed. Note changes from the list submitted with our last report. We have also recently revised our DCP site map. This too is inclosed.

CRREL (The U.S. Army Cold Regions Research and Engineering Laboratory) has installed a Martek Instrument Co., Inc. Mark III Water Quality Monitoring System, together with one of their test DCP's, at Wilder Dam on the Connecticut River. Sensors are six feet down beneath the water surface in the river next to the dam. They are monitoring: depth of water above sensor, temperature of the water, conductivity, pH, dissolved oxygen and air temperature (with a diode).

DCS data relay from NASA via our real time teletype link continues to be timely, with a lag of approximately 45 minutes between ERTS-1 passover and arrival of the data at the New England Division. Punched cards and computer printouts of our data continue to arrive in a timely manner by mail.

The ERTS-1 DCP hardware continues to perform well. Sensor-related equipment problems are now of minimal effect. Most failures in the DCS system since our last report have been due to battery expiration, and these only after prolonged battery use. The "Gel-Cell" batteries that power the DCP installations continue to last between 5 and 12 months. The average life of the batteries that have expired, to date, is 7.25 months.

DCS data continues to show a high degree of reliability. Starting 20 September 1973 we began to receive messages of all confidence levels from NASA instead of only messages with the highest confidence level (7). Thus, prior to 20 September many reports originally comprising both good and bad messages were screened by NASA and only the remaining good messages were sent to us, leading us to classify these reports as good. Under such circumstances, from 1 January through 9 September, DCS reliability (good reports/total reports received) was calculated to be 97.7 percent. Now that we are receiving all messages we plan to alter our system of classification. If two consecutive messages within a report contain the same values for parameters being measured, it will be considered a good report regardless

of the confidence level of the messages. Updated reliability statistics will be calculated and reported.

We are continuing to actively pursue our interest in having a direct DCS downlink installed at our Waltham Headquarters. We are firmly convinced that the concept of regional downlinks must be considered, and such a setup physically tested, in relation to the development of the specifications for any operational satellite data collection system.

Imagery activities for the entire period of our ERTS-1 investigation through 1 September 1973 are being consolidated in the form of a technical report. The major features include an evaluation of the ERTS-1 imagery system to provide useful hydrologic information for Corps of Engineers operations in the NED region, results of using ERTS-1 in the investigation and evaluation of individual hydrologic parameters, and proposed models for further application of ERTS-1 imagery data in the evaluation of these parameters.

Most of the remainder of the reporting period was spent in the continued study and evaluation of snow and snowmelt phenomena as revealed by ERTS-1 during the period January through April 1973. Additive color techniques were used to produce color composite snow maps from ERTS-1 imagery. For regular snow mapping it was found that Diazo polyester color prints of 9.5 x 9.5 inch ERTS-1 positive transparencies are satisfactory for making single band color overlays of ERTS-1 frames to give wide area regional coverage (four or more adjacent ERTS frames). With proper registration, composite images can be obtained for the combination of two or more bands. The individual colored overlays indicate absorption in the particular bands when positives are used (as opposed to reflection in the case of negatives). The best color combination for snow mapping was judged to be:

MSS - 7: Cyan  
MSS - 5: Magenta  
MSS - 4: Red

It provides good contrast between snow/nonsnow covered areas. A striking feature of using color composites in this manner is that variations in quality of water in the solid or quasi-solid phases are greatly enhanced. Some significant observations are the following:

a. Color composites enhance the contrasts between ice covered and snow covered areas. Ice covering surface waters such as rivers and lakes shows up as a light cyan color whereas snow covering shows up as white in the above mentioned combination. This implies that over ice some absorption is occurring in band 7 while reflection is still predominant in bands 4 and 5. This selective absorption of near - IR radiation in the case of ice may be due in part to the underlying liquid water and/or to the denser more crystalline properties of ice as opposed to the particulate structure of snow.

b. Color composites greatly enhance the contrasts between snow and nonsnow covered areas.

c. Comparisons between winter and early spring snow scenes indicate that the greater illumination provided in the early spring due to a higher sun angle appears to increase the contrast between snow and nonsnow covered areas by overcoming the interference of vegetative cover. Furthermore, while the reflectance from both snow and nonsnow covered land increases at this season, the increase in reflection occurring over snow covered areas appears to be greater, thus increasing the overall contrast between the two. Finally, mid-winter shadows, which in some respects tend to highlight or enhance terrain and geological features, at the same time tend to obscure snow cover. In fact, shadows of trees in heavily forested areas caused by the low winter sun angle appear to be as much or more of an obscuring factor than the vegetative "mat" of trees themselves.

In a previous progress report, observed snow melting phenomena were mentioned as having occurred in the overlap region of two adjacent ERTS-1 orbital paths, one day apart in time. Overlapping sections of image frames taken on the two successive days, 6 and 7 April 1973 (E-1257 and E-1258), were overlaid to show the decrease in snow cover caused by melting which took place during the intervening 24 hours. The Contoocook River basin, a sub-basin of the Merrimack River basin in western New Hampshire was located entirely within the overlap region. It appeared to have considerable snow cover on 6 April as indicated by imagery and meteorological records, with an obvious drastic reduction by 7 April, except in the upper elevations along the basin divides. Estimates of increased snowmelt and runoff were made by two entirely independent methods and revealed that perhaps 0.2 to 0.3 inch of snow as water equivalent had melted over the 766-square mile basin in the intervening 24-hour period between coverages by ERTS-1. Most of this showed up as runoff at the mouth of the river. Thus, besides providing a visual representation of a dynamic hydrologic

event, some indication was provided by ERTS imagery of the amount of water stored as snow accumulation. The photo interpretations and hydrologic analyses are being assembled into a technical report.

We are currently considering extending our subcontract with the University of Connecticut for the study of ERTS imagery. This would be primarily for the determination of the potential usefulness of ERTS-type imagery for NED water related purposes both during and after a significant flood event, using data from the late June - early July 1973 New England flood.

During the reporting period CRREL completed and delivered to NED, for display purposes, two identical ERTS-1 imagery mosaics of all New England at a scale of 1:500,000. These were constructed of a mixture of MSS-6 and 7 scenes taken during September and October 1972 and are negative renditions to enhance surficial waters.

We continue to be in contact with other ERTS investigators, and especially personnel from NASA, the U.S. Department of the Interior, and the National Oceanic and Atmospheric Administration. We are carefully following developments regarding the GOES Data Collection System.

No data requests were submitted to NASA since our last Type I report. Beginning 20 September we began receiving DCS messages from NASA at all confidence levels, compared to receipt of confidence level 7 data only prior to that date.

2 Incl  
As stated

  
SAUL COOPER  
Principal Investigator

ERTS-1 - DCP INFORMATION SHEET  
ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION

14 OCT, 1973

ID NO.	DCP NO.	TYPE*	STATION NAME	LAT	LONG	IN-STALLED
1	6233	S	ST. JOHN RIVER AT FORT KENT, MAINE	47 15	68 35	091972
8	6220	S	ST. JOHN RIVER AT NINEMILE BR., MAINE	46 42	69 43	073073
2	6355	S	PENOBSCOT RIVER AT WEST ENFIELD, MAINE	45 14	68 39	092072
3	6246	S	CARABASSETT RIVER AT NORTH ANSON, MAINE	44 52	69 57	100472
5	6171	S	SACO RIVER AT CORNISH, MAINE	43 48	70 47	112872
6	6273	S	PEMIGEWASSET RIVER AT PLYMOUTH, N.H.	43 45	71 41	112272
7	6304	S	MERRIMACK RIVER AT GOFFS FALLS, N.H.	42 57	71 28	032773
9	6356	S	CHARLES R. AT CHARLES R. VILLAGE, MASS.	42 15	71 15	071772
10	6207	S	TOWN BROOK AT QUINCY, MASS.	42 15	71 00	090872
41	6142	S	NORTH NASHUA RIVER AT FITCHBURG, MASS.	42 34	71 47	110672
11	6010	S	PAWTUXET RIVER AT CRANSTON, R.I.	41 45	71 27	090672
13	6106	S	BRANCH RIVER AT FORESTDALE, R.I.	42 00	71 34	100173
12	6127	S	CONNECTICUT RIVER AT HARTFORD, CONN.	41 46	72 40	083072
20	6042	P	STINSON MOUNTAIN, N.H.	43 50	71 47	032273
21	6345	P	SOUTH MOUNTAIN, N.H.	42 59	71 35	120672
22	6206	P	FRANKLIN FALLS DAM, N.H.	43 28	71 40	051773
23	6201	P	BLACKWATER DAM, N.H.	43 19	71 44	100273
24	6012	P	MACDOWELL DAM, N.H.	42 54	71 59	042473
26	6071	P	WACHUSETT MOUNTAIN, MASS.	42 29	71 53	100473
25		P	MANSFIELD HOLLOW DAM, CONNECTICUT	41 46	72 11	
30	6101	C	STAMFORD BARRIER, STAMFORD, CONNECTICUT	41 02	73 32	011073
40	6254	Q	ASHUELOT RIVER AT WINCHESTER, N.H.	42 47	72 23	121272
42	6272	Q	WESTFIELD R. AT WEST SPRINGFIELD, MASS.	42 06	72 38	092872
43	6242	Q	CHICOPEE RIVER AT CHICOPEE, MASS.	42 09	72 35	121472
50	6147	T	NED HEADQUARTERS, WALTHAM, MASS.	42 24	71 13	071772
51	6325	T	COLD REGIONS LAB AT HANOVER, N.H.	VARIABLE		042373
52	6216	T	COLD REGIONS LAB AT HANOVER, N.H.	VARIABLE		120572
54	6063	T	U.S. GEOLOGICAL SURVEY, BOSTON, MASS.	VARIABLE		032073

\* S-RIVER STAGE

P-PRECIPITATION

C-COASTAL(WIND DIRECTION,VELOCITY AND TIDE)

Q-WATER QUALITY(TEMPERATURE,CONDUCTIVITY,PH AND DISSOLVED OXYGEN)






T-TEST SET(SENSORS VARIABLE)



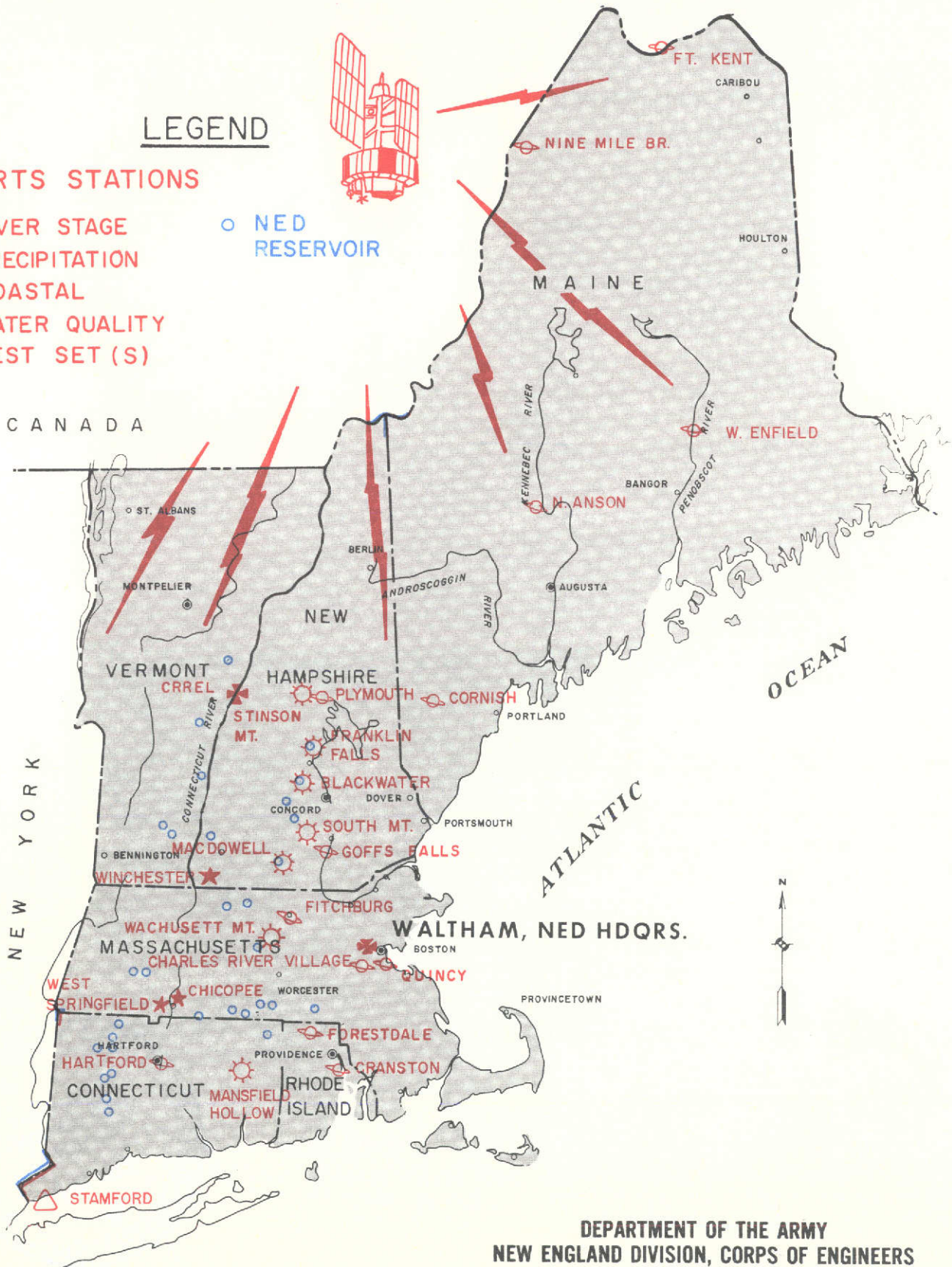
# ERTS-1 DATA REPORTING STATIONS

## LEGEND

### ERTS STATIONS

-  RIVER STAGE
-  PRECIPITATION
-  COASTAL
-  WATER QUALITY
-  TEST SET (S)

 NED  
RESERVOIR



DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS.  
SEPTEMBER 1973